

Possibility of EUVL System at the wavelength of 6.8nm

Center for EUV Lithography
University of Hyogo

Hiroo Kinoshita



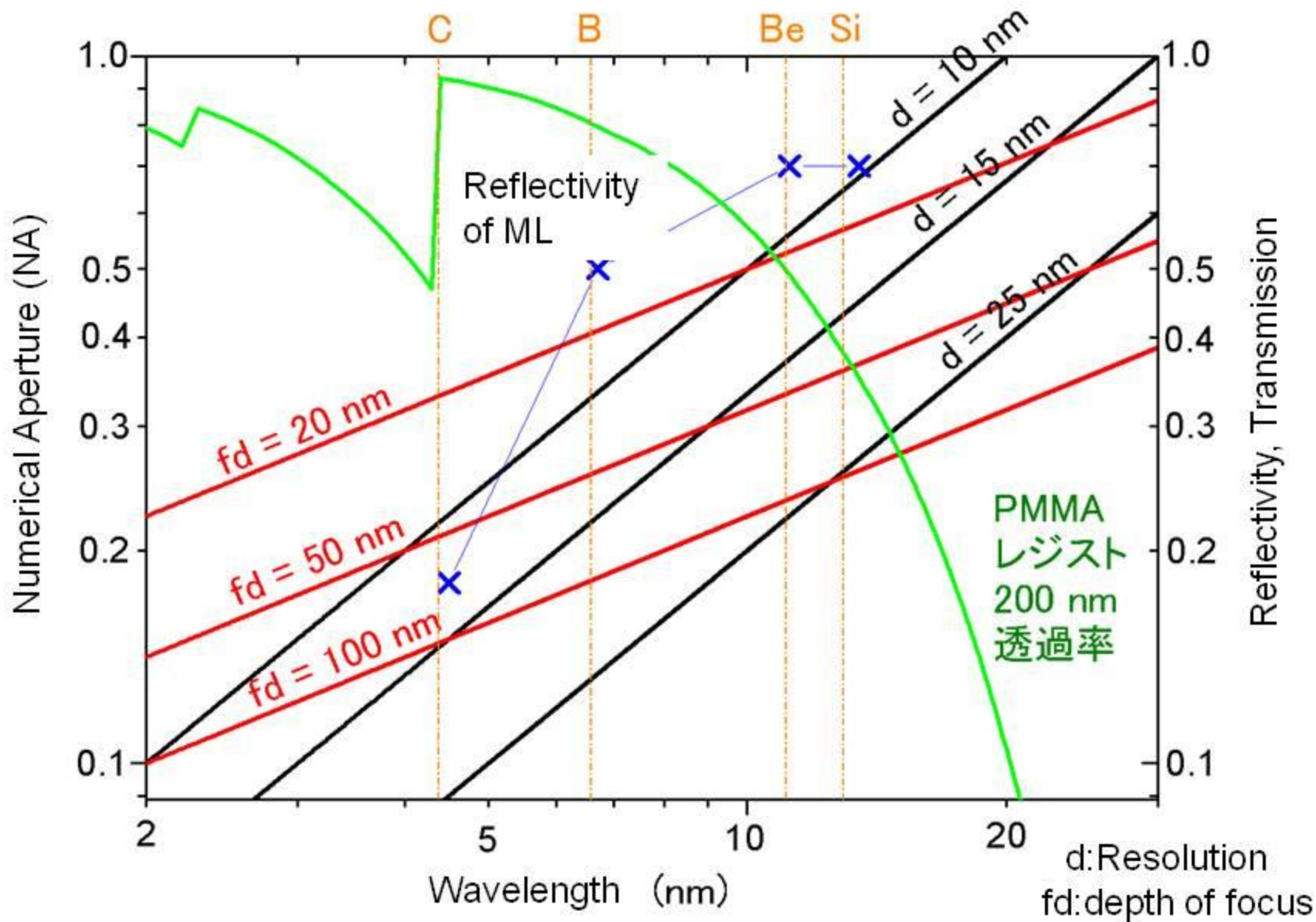
Outline

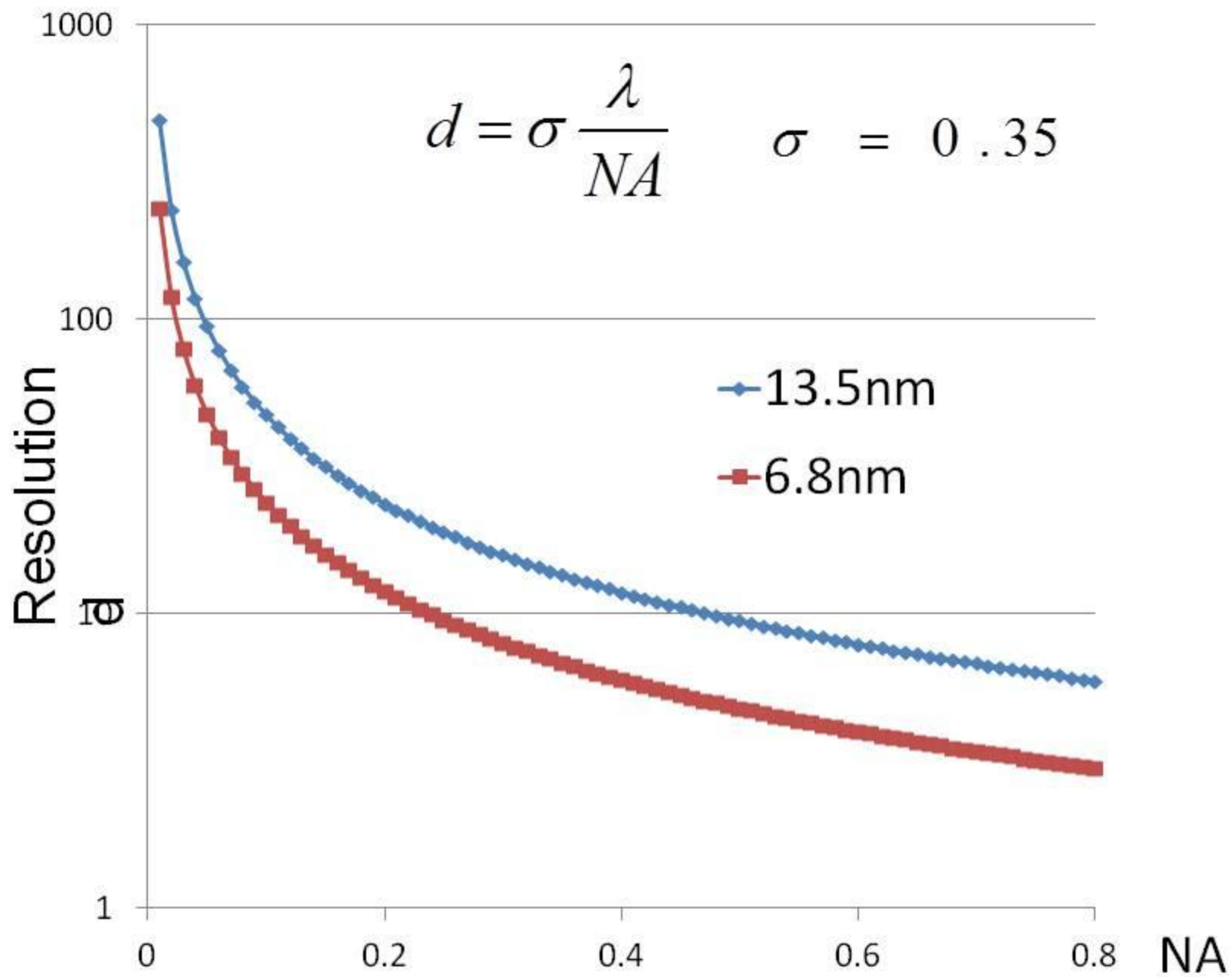
- Introduction
- Selection of exposure wavelength
- Standpoint of multilayer
- Standpoint of resist characteristics
- Summary

Technology Outlook

High Volume Manufacturing	2008	2010	2012	2014	2016	2018	2020	2022
Technology Node (nm)	45	32	22	16	11	8	6	4
Integration Capacity (BT)	8	16	32	64	128	256	512	1024
Delay Scaling	>0.7			~1?				
Energy Scaling	~0.5			>0.5				
Transistors	Planar			3G, FinFET				
Variability	High			Extreme				
ILD	~3			towards 2				
RC Delay	1	1	1	1	1	1	1	1
Metal Layers	8-9	0.5 to 1 Layer per generation						

Source: Intel's Corporate Technology Group





EUV and BEUV product roadmap spans >10 years

	0.25 NA		0.32 NA		<i>Under study</i>	
					>0.40 NA	
Lens mirrors	6M	6M	6M	6M	6/8M	6/8M
Wavelength	13.5 nm	13.5 nm	13.5 nm	13.5 nm	13.5 nm	New λ
Product	ADT	3100	3300B	3300C	3500	>3500
Introduction year	2006	2010	2012	2013	2016	>2018
Resolution (hp)	32 nm	27 nm	22 nm	18 nm	11 nm	<8 nm
Sigma	0.5	0.8	0.2-0.9	OAI	flex OAI	flex OAI
Overlay (SMO)	7.0 nm	4.5 nm	3.5 nm	3.0 nm		
Throughput (wph)	4 wph	60 wph	125 wph	150 wph		
Dose (mJ/cm ²)	5	10	15	15		
Source (W)	3	105	250	350		

Possible new wavelength = 6.x nm

Multilayer

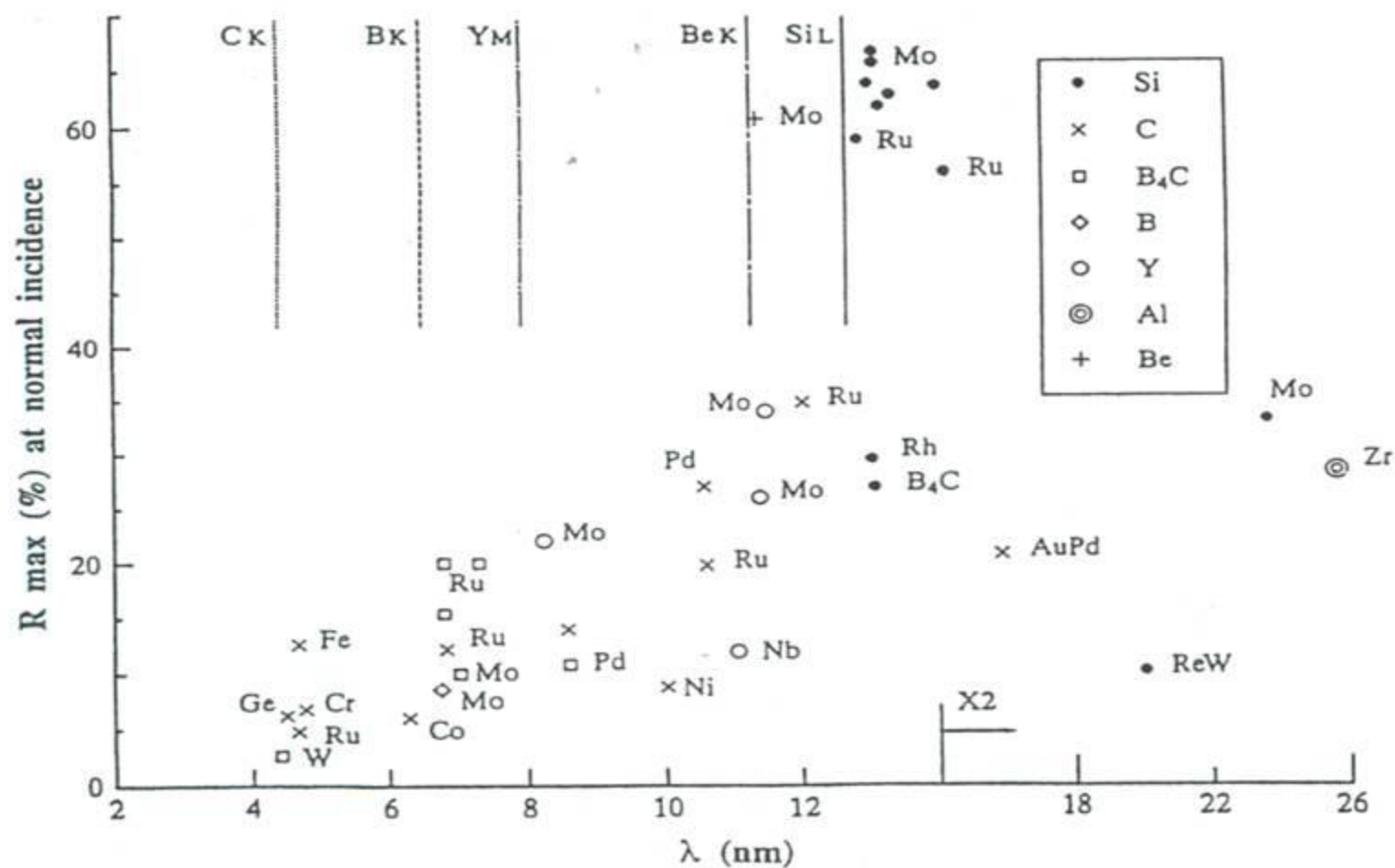
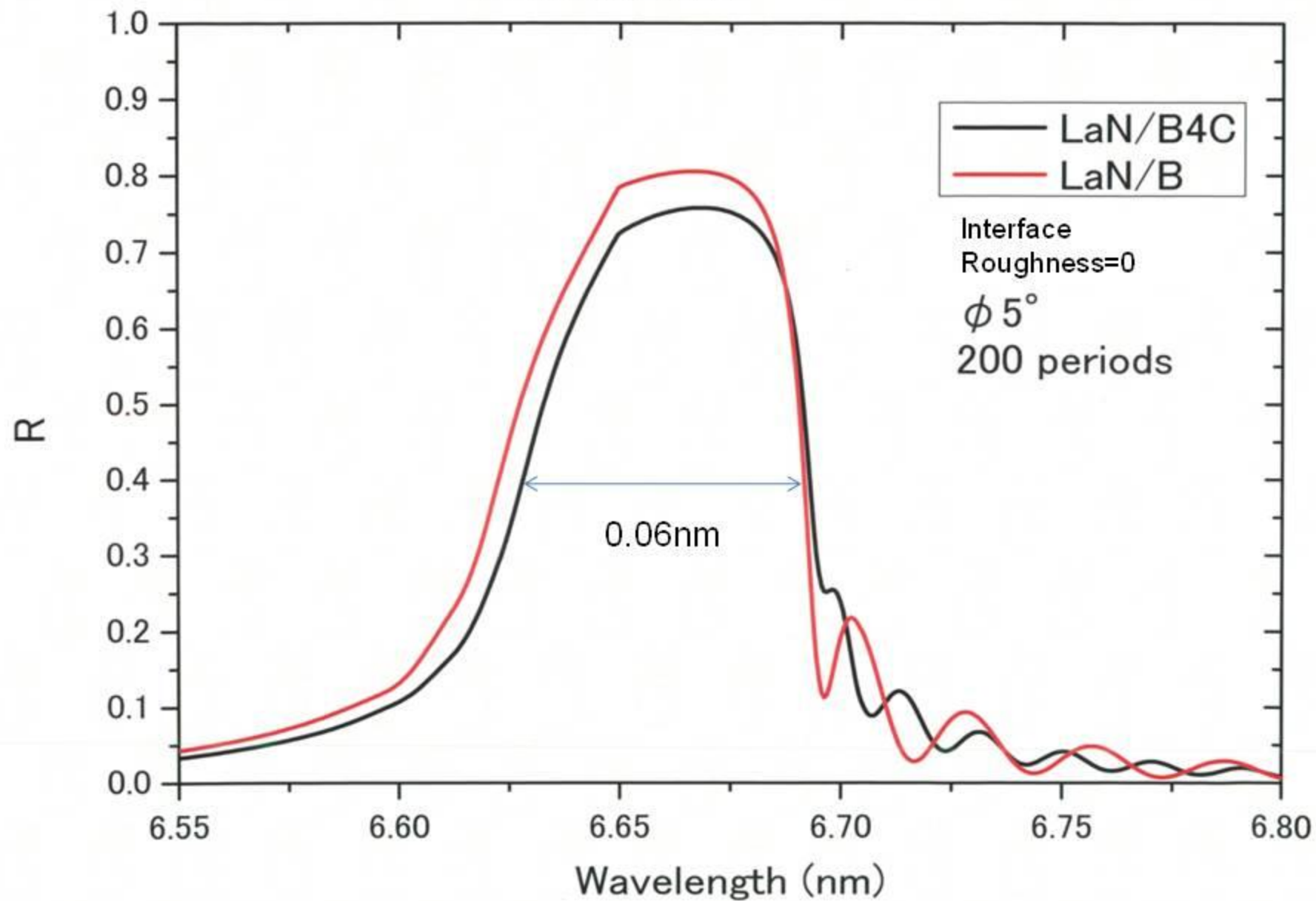
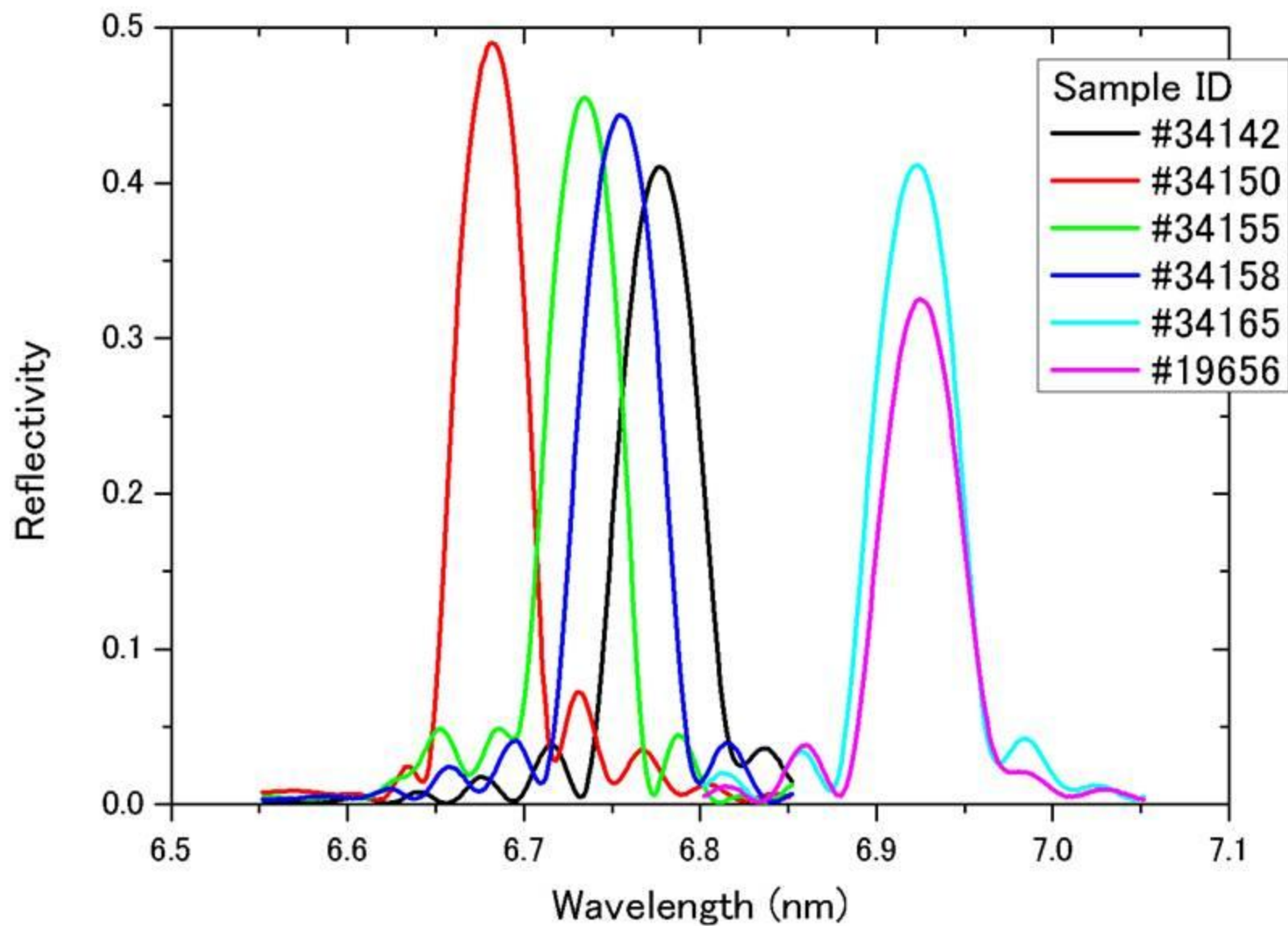
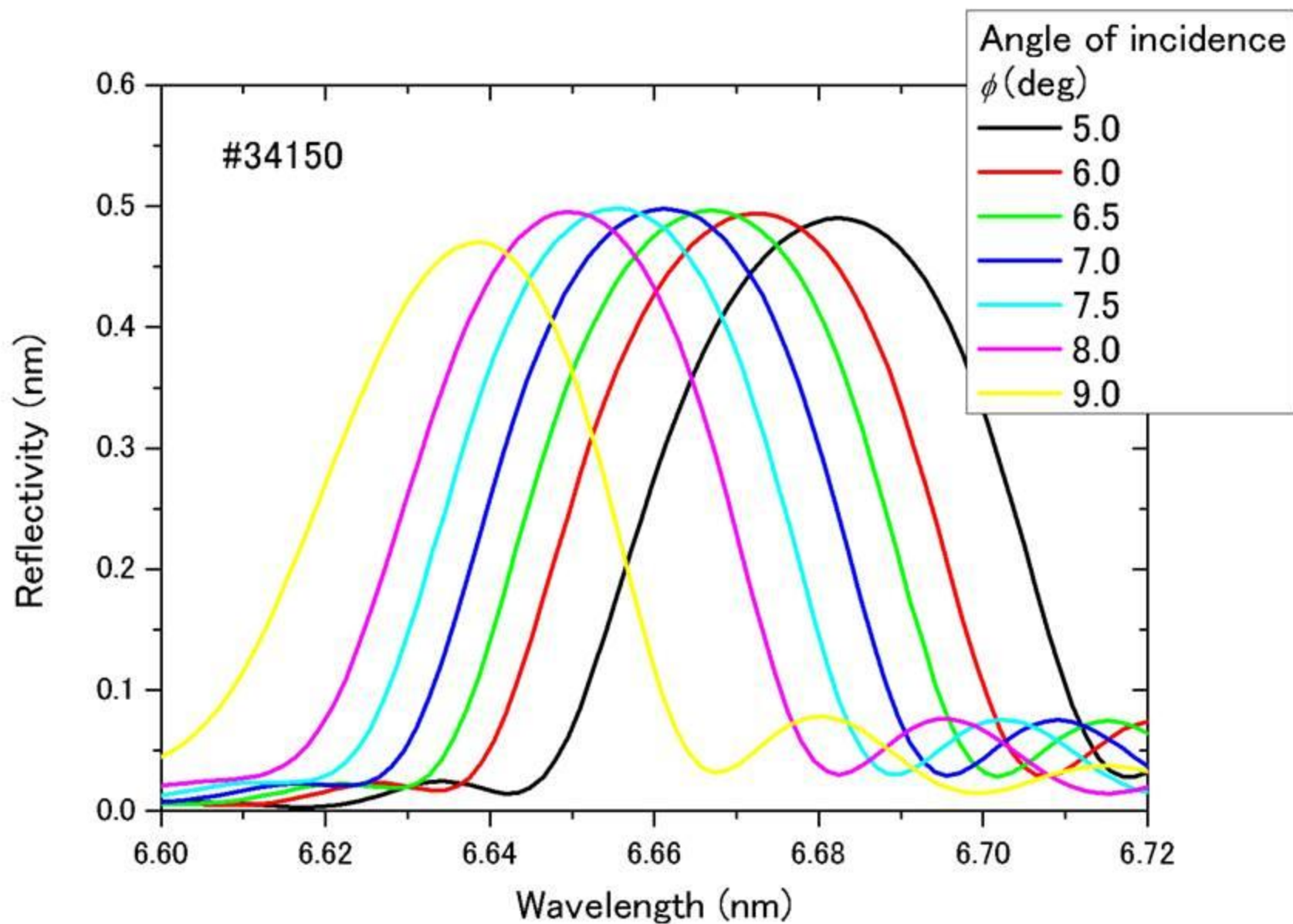


图 3 当前趋势的最佳反射率 vs. 波长与各种材料对。

Theoretical value



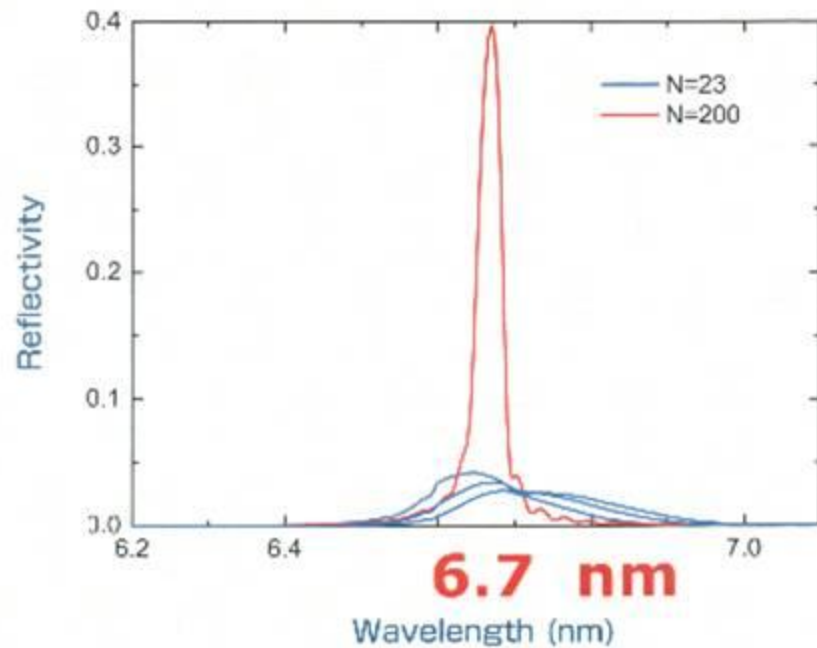
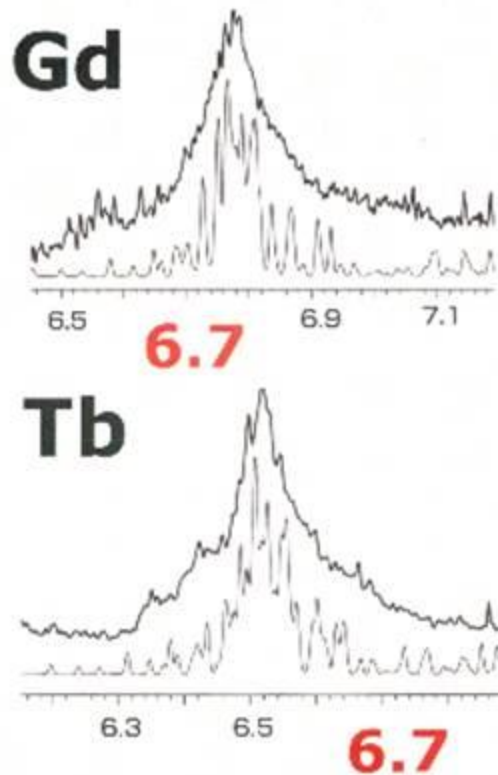




What's next?

6.7 nm: Gd, Tb plasmas

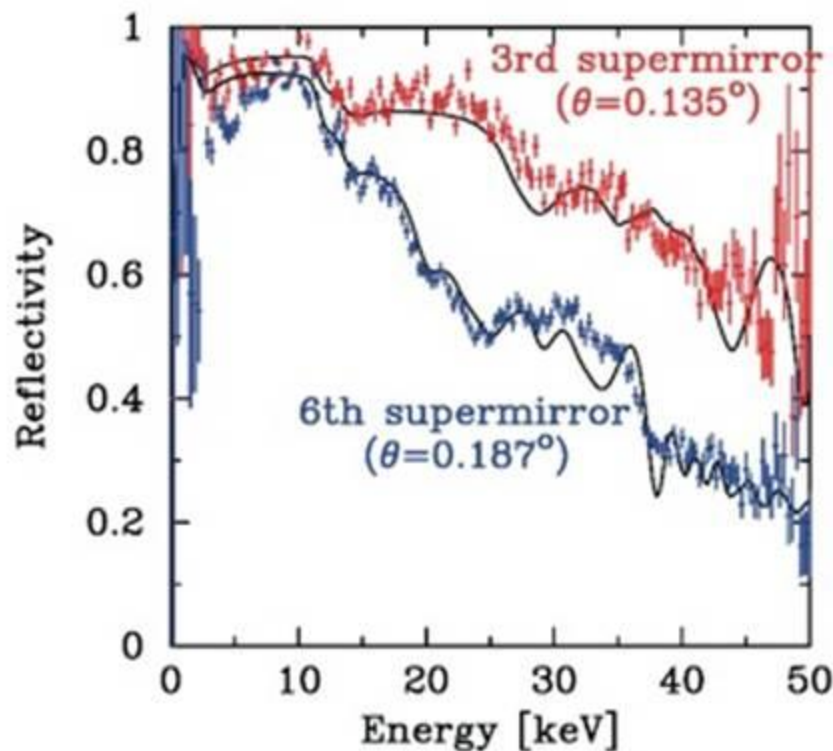
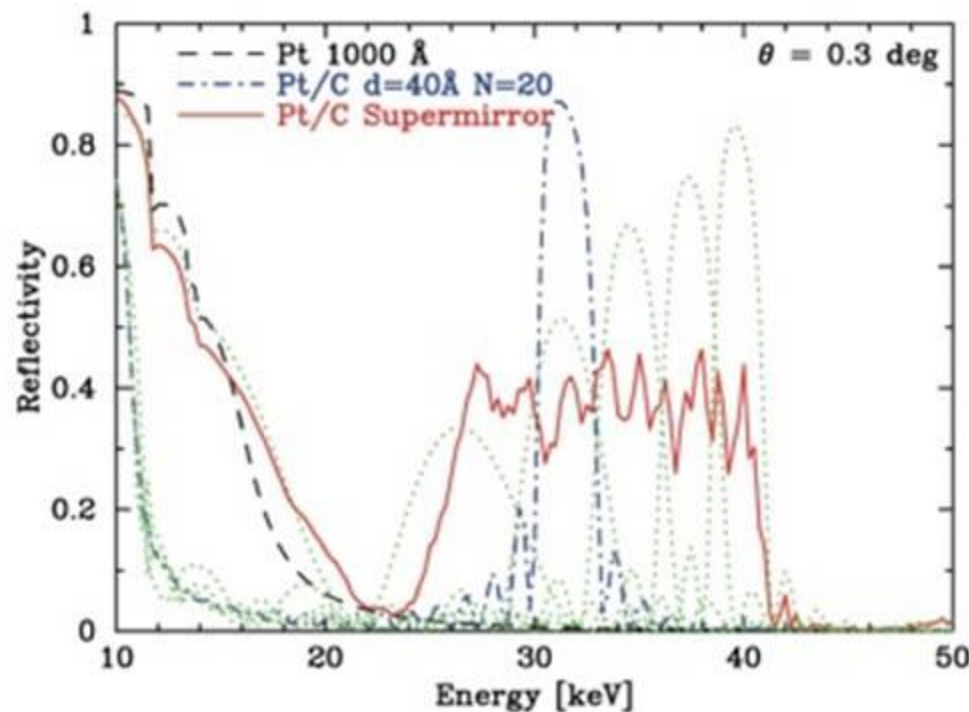
Mo/B₄C mirror



S. S. Churilov et al., Phys. Scr. **80**, 045303 (2009)

Courtesy Dr. Higashiguchi

Example of Super mirror



Effective for hard x-ray region, not soft-x-ray region

Resist

The following data sited from
Chris Anderson, etal. "The SEMATECH Berkeley MET
demonstration of 15-nm half pitch in chemical amplified
EUV resist and sensitivity of EUV resist at 6.X-nm."
Proc. SPIE 8322,832212(2012)

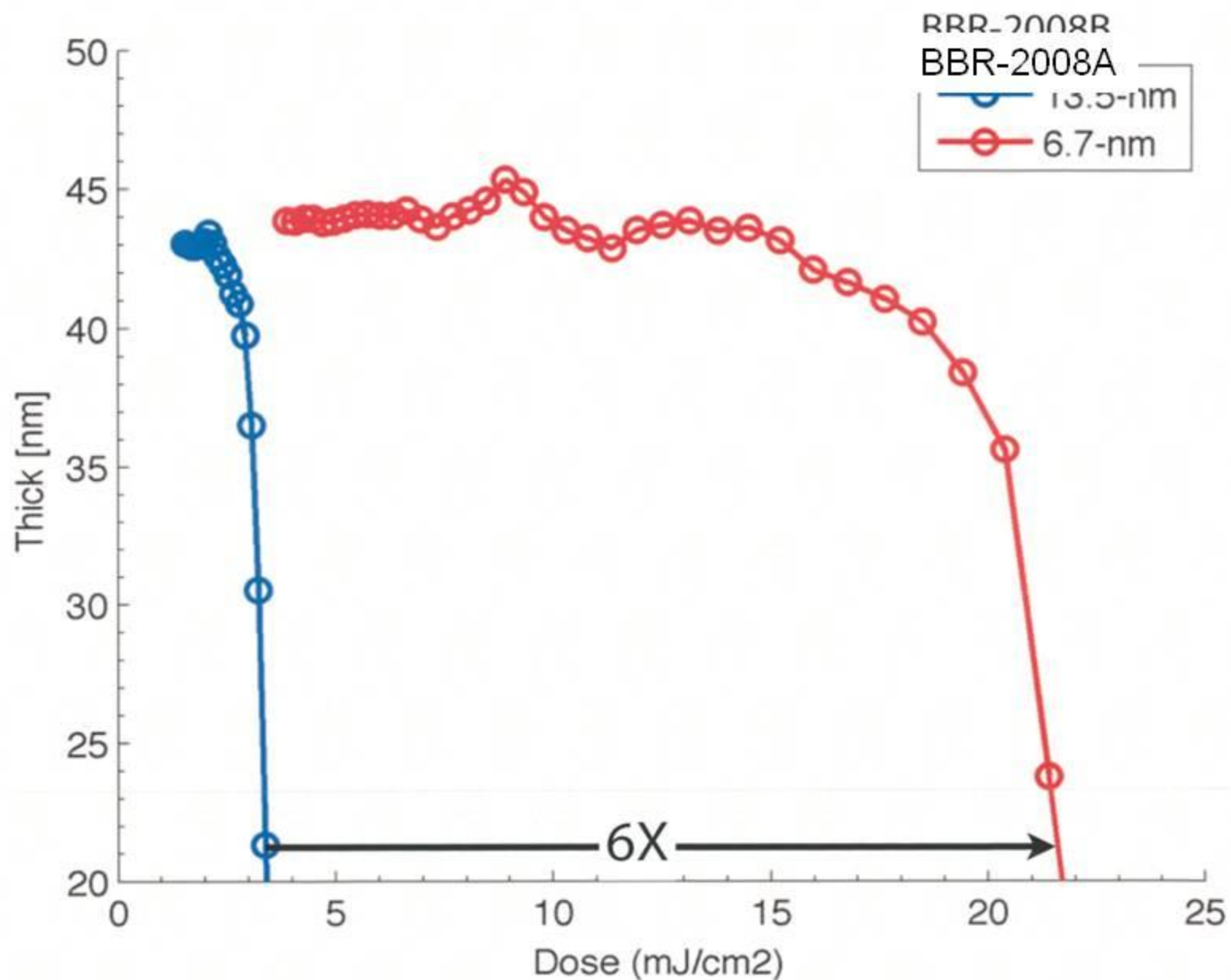
Courtesy Dr. Chris Anderson and Patrick Naulleau

We have tested three materials:

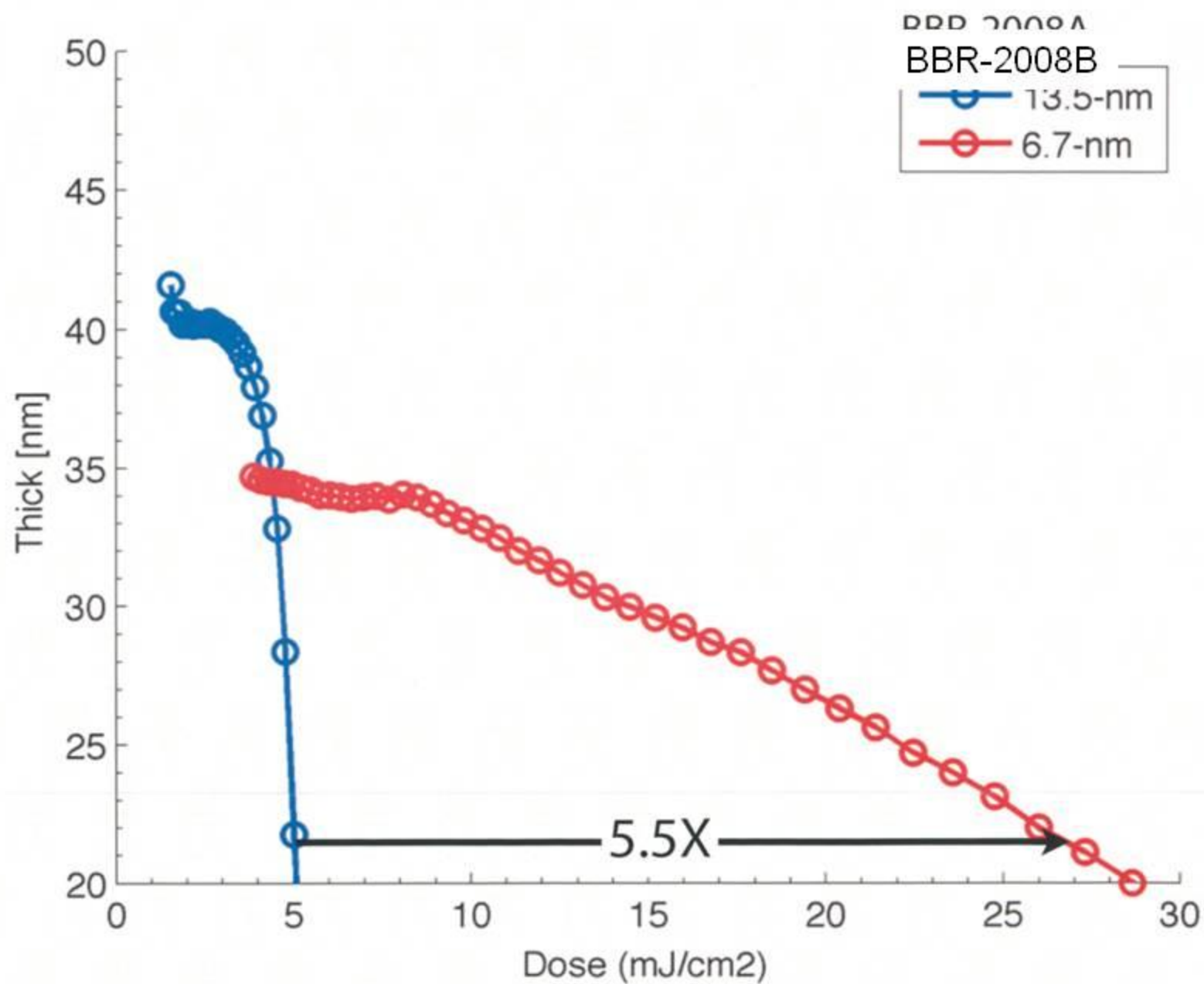
1. BBR-2008A (organic, CA, 19-nm HP)
2. BBR-2008B (organic, CA, 24-nm HP)
3. Inpria XE15IB (inorganic, 15-nm HP)



6.7-nm contrast curves

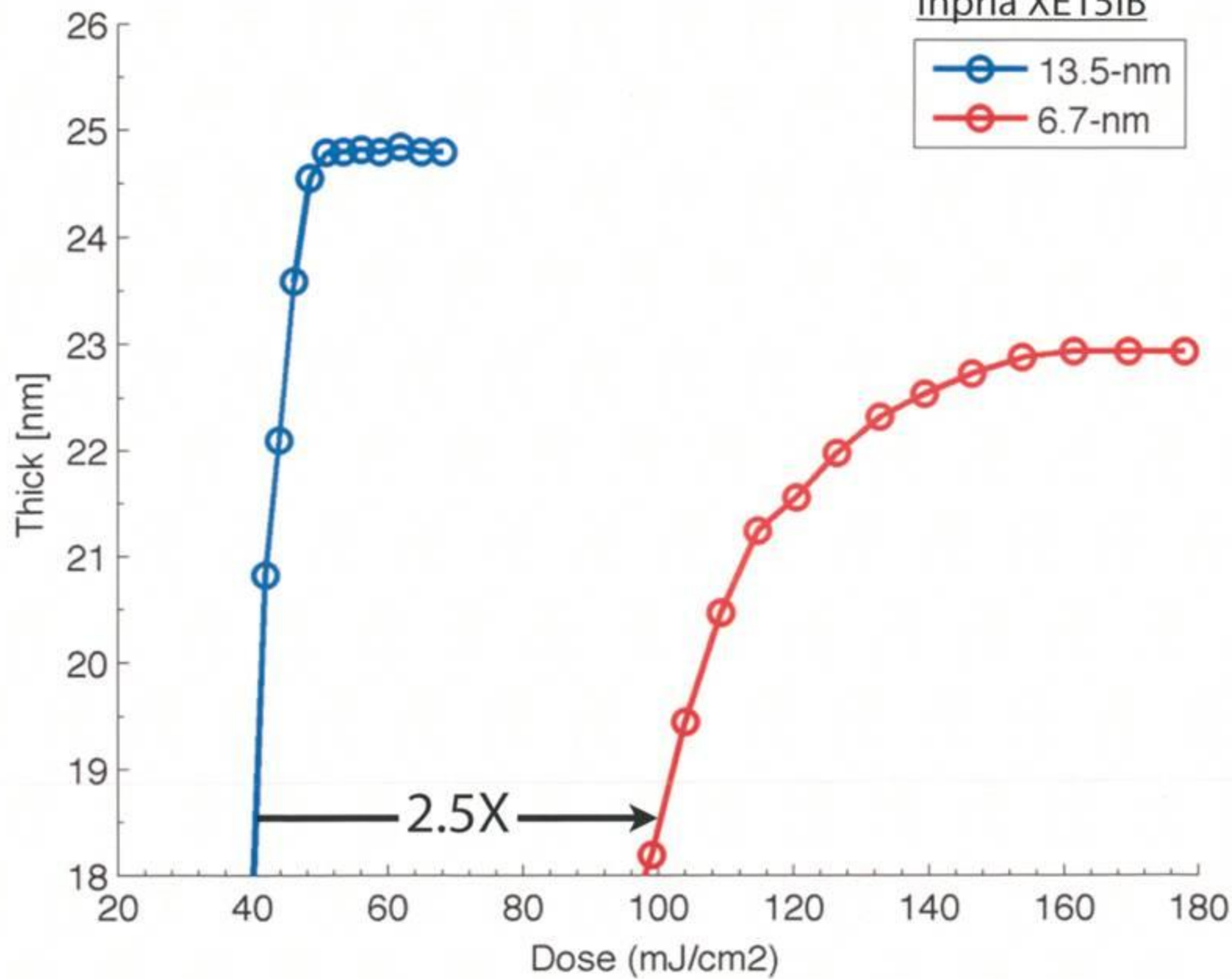


Courtesy Dr. Chris Anderson and Patrick Naulleau

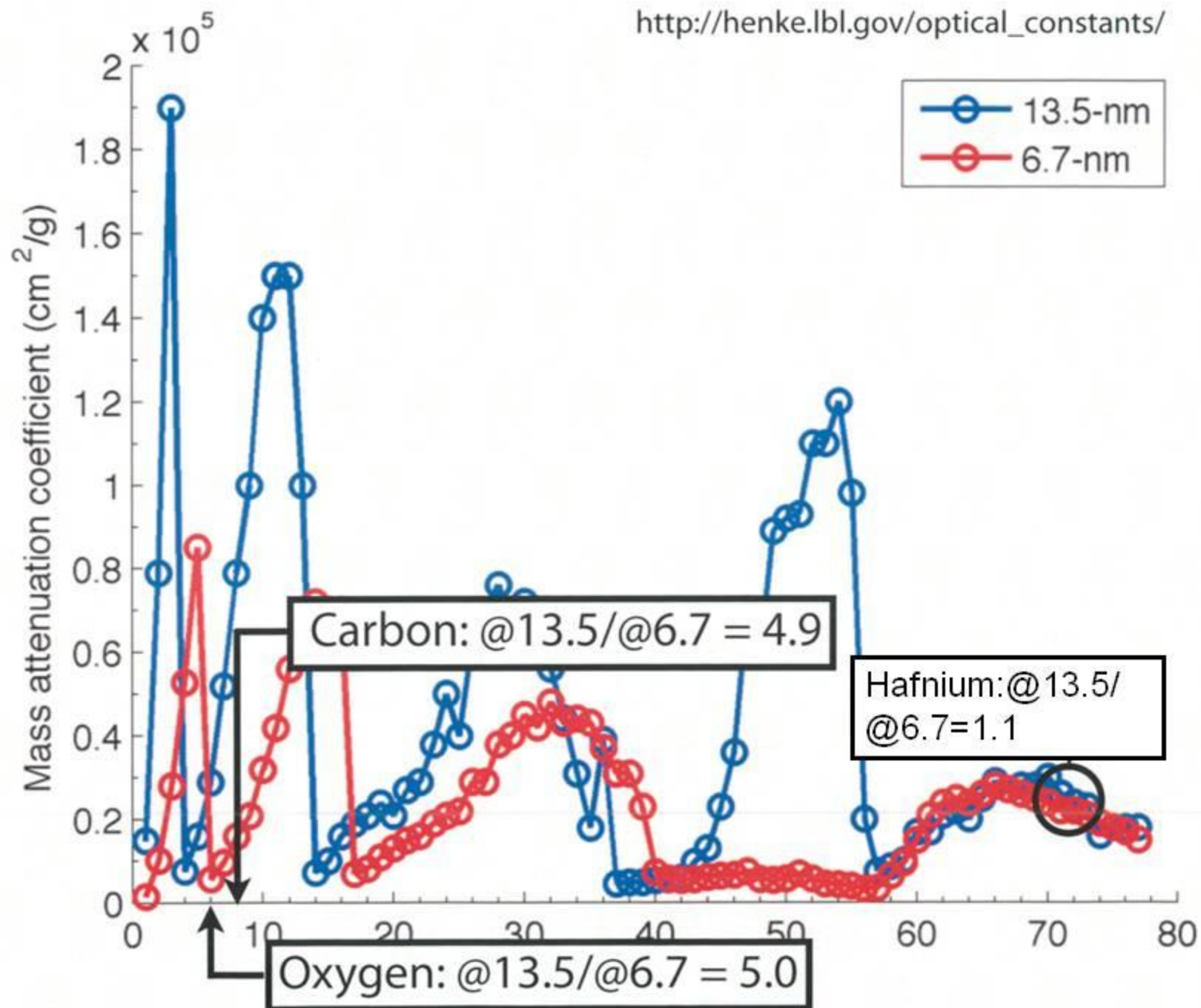


Courtesy Dr. Chris Anderson and Patrick Naulleau

Inpria XE15IB



Courtesy Dr. Chris Anderson and Patrick Naulleau



Summary

- New wave length has to be selected in consider multilayer reflectivity and sensitivity of resist.
- Multilayer of LaN/B4C shows the highest reflectivity at this region, but required bandwidth is so narrow.
- Transmission and penetration depth become larger, but the sensitivity which define the source power is so low.

Please submit the new proposal on 13.5 nm.